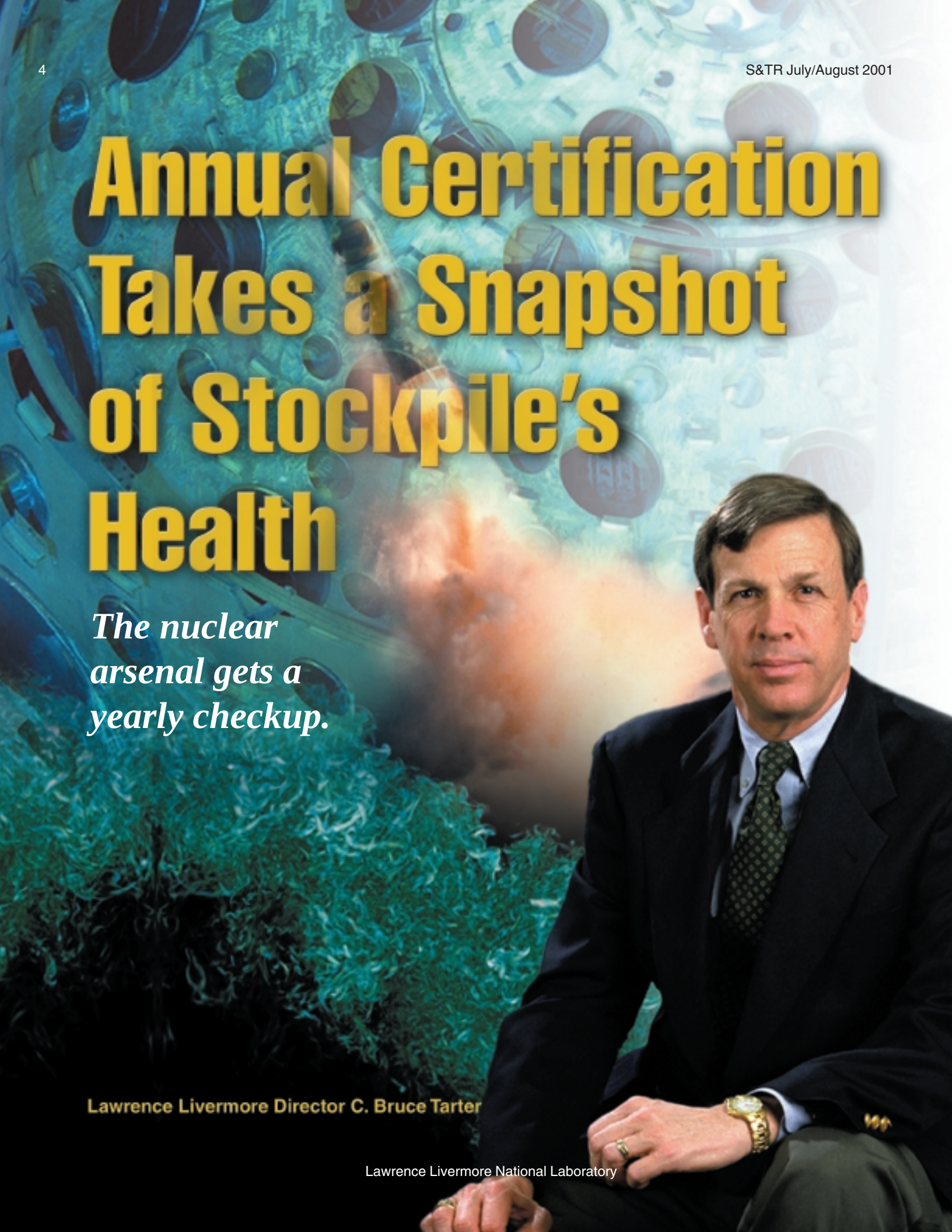
Annual Certification Takes a Snapshot of Stockpile's Health

The nuclear arsenal gets a yearly checkup.



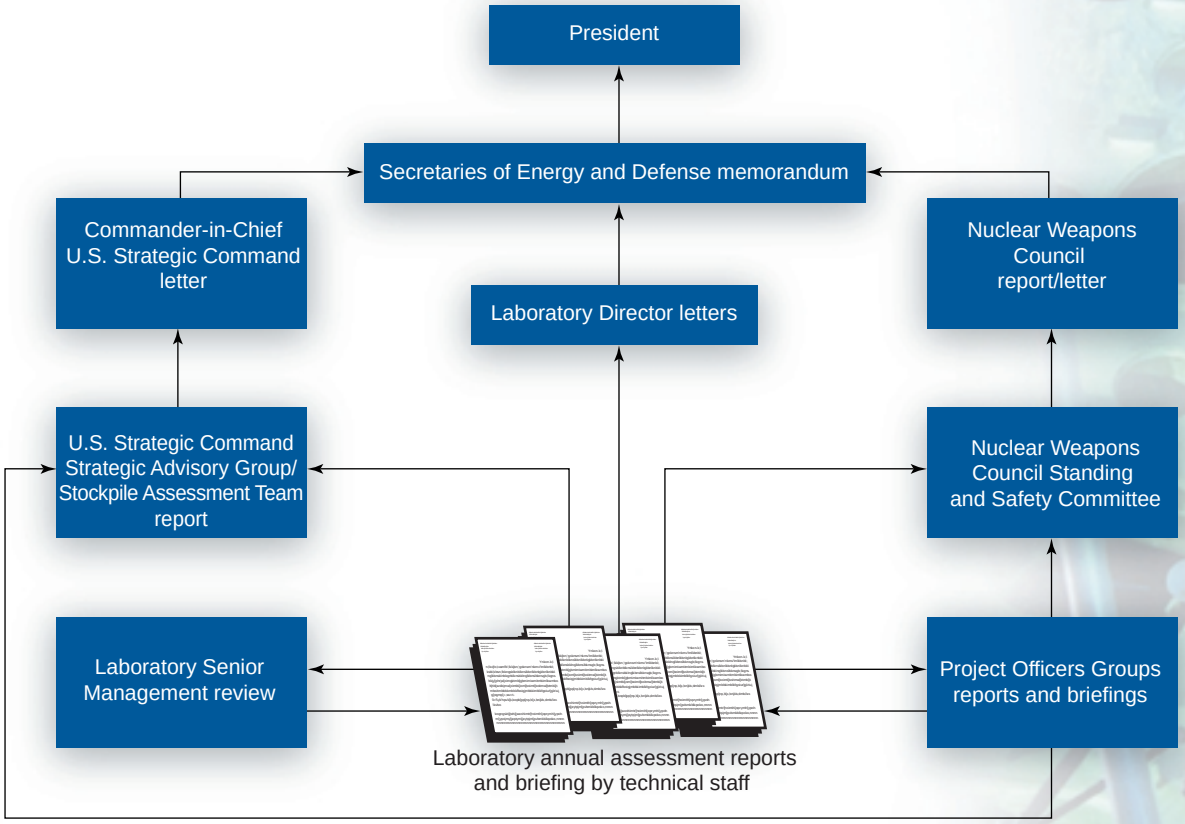
Lawrence Livermore Director C. Bruce Tarter

As director of Lawrence Livermore, Bruce Tarter faces a host of significant responsibilities: directing the overall research activities of more than 8,000 employees, managing a budget of more than $1 billion, and testifying before Congress about key national security issues. Yet nothing is more important than one yearly task, that of signing a letter stating whether nuclear weapon systems with Livermore designs have major safety or reliability issues that must be resolved with underground nuclear testing.

The director's letter, and those from the directors of the Department of Energy's other two national security laboratories, Sandia and Los Alamos, are part of an exhaustive, largely standardized process called Annual Certification. The process is a formal assessment and reporting of the status of the nation's stockpile of nuclear warheads and bombs. The first Annual Certification was completed in February 1997, and the sixth is under way.

The Annual Certification process plays a central role in ensuring that everyone in the nuclear enterprise, from top to bottom, has a common understandng of the health of the stockpile. This understanding is based on thorough technical evaluations by staff at the Livermore, Los Alamos, and Sandia national laboratories; statements by their directors; and findings by the joint DOE National Nuclear Security Administration (NNSA)/Department of Defense (DoD) Project Officers Groups (POGs), the commander-in-chief of the Strategic Command, and the Nuclear Weapons Council. Ultimately, the secretaries of Energy and Defense report in a written memorandum (classified by law beginning in 2000) to the president concerning the safety and reliability of the stockpile and whether a resumption of nuclear testing is needed. Several other agencies, groups, and advisory panels also play important roles.

"Annual Certification is a review of the status of the nuclear stockpile based on the results of ongoing stockpile



The Annual Certification process is based on technical evaluations by Lawrence Livermore, Los Alamos, and Sandia national laboratories; statements by their directors; and findings by the joint DOE National Nuclear Security Administration/Department of Defense Project Officers Groups, the commander-in-chief of the Strategic Command, and the Nuclear Weapons Council and its Standing and Safety Committee. The secretaries of Energy and Defense report in a memorandum to the president on the safety and reliability of the stockpile and whether a resumption of nuclear testing is needed.

stewardship work," says Jim Tyler, physicist and program manager for stockpile support. Tyler, who leads the annual effort at Lawrence Livermore, explains that Annual Certification is a "snapshot" of the nation's stockpile, drawing on all aspects of the Stockpile Stewardship Program. Director Tarter compares it to an annual physical.

Tyler notes that a common confusion arises from the term "certification," which has a special meaning to nuclear stockpile managers. Weapons are certified when they are originally built or when a significant modification is made to them, and this certification doesn't expire each year.

Annual Certification, however, is an assessment of the current stockpile and not a formal certification of the stockpile weapons. "We don't recertify the stockpile warheads and bombs every year. We put together an assessment of the status of the stockpile and present it to the government," he explains.

Process Starts at the Labs

At the three national security laboratories, the Annual Certification process begins in January with the drafting of nine Annual Assessment Reports. The nine reports correspond to the nine nuclear weapon designs that comprise the nation's nuclear stockpile (see box on p. 7). Each report reviews the status of a particular warhead or bomb system. The reports also include a description of each system's current role and planned future role in the nation's stockpile and any ongoing or planned modifications. A key portion of each report discusses whether nuclear testing is warranted.

Lawrence Livermore and Sandia/California staffers prepare four reports, called the California reports, that describe the status of the four nuclear weapons designed by their two laboratories: the W62, W84, and W87 warheads and the B83 bomb. These four weapon systems have been or are expected to remain in the stockpile well past their originally anticipated lifetimes; in fact, the W62 is already well past its lifetime. Los Alamos and Sandia/New Mexico experts compile the drafts of the New Mexico reports on the five stockpiled nuclear weapon systems designed at Los Alamos and Sandia.

For the dozens of Livermore weapons specialists involved in Annual Certification, the draft report process involves a comprehensive review of the Laboratory's stockpile stewardship activities pertaining to each of the four weapon systems. Stockpile stewardship is the program managed by NNSA to maintain the nation's nuclear arsenal in the absence of nuclear testing by using improved scientific and engineering tools. The program was created in the early 1990s in response to the cessation of underground nuclear testing (see box on p. 8). "The quality of our Annual Assessment Reports can be no better than the quality of our day-to-day stockpile stewardship effort," says Tyler.

A major element of stockpile stewardship is regular surveillance of stockpile weapon systems to evaluate the evolving status of the warheads and bombs as they age. Livermore has

The W84 warhead, now inactive, was designed for the Ground Launched Cruise Missile, seen in this test launch.

A test launch of the Minuteman III ICBM (intercontinental ballistic missile), which is equipped to carry the W62 warhead.

A mock B83 bomb is dropped from a B-2 bomber in this flight test. Such tests are conducted as part of stockpile surveillance activities.

special responsibilities for the surveillance of the four weapon systems that feature its nuclear designs. These responsibilities include assessing the systems' safety and potential performance and planning for any refurbishment that might be needed in the future.

In assembling the draft reports, Laboratory managers collect and analyze information from surveillance activities as well as physics, engineering, and chemistry and materials science data from a complement of stockpile stewardship activities called "baselining." Lawrence Livermore scientists, engineers, and technicians use baselining tools such as advanced computer simulations, component-level experiments, subcritical experiments involving plutonium and high explosives at the Nevada Test Site, nonnuclear experiments at Livermore's remote Site 300, and analysis of historical data from past nuclear tests. Baselining supports surveillance work assessments and response decisions, Tyler says.

By the end of March, after thorough internal review by technical leaders, the initial drafts of the nine Annual Assessment Reports are distributed among the three laboratories and NNSA personnel for review and comment. In this way, stockpile issues are reviewed and discussed by appropriate people throughout the NNSA community instead of only by scientists and engineers at the laboratories that designed the original weapon and who have primary responsibility for its surveillance. Indeed, the use of various forms of peer review has become a key component of many stockpile stewardship efforts because it minimizes the potential for unrecognized errors by one group or organization.

Comments and questions about the draft reports are discussed at a two-day meeting at Sandia/New Mexico in mid-April that is attended by representatives from NNSA and the laboratories. Livermore sends about two dozen people to the meeting, including managers, physicists, engineers, and materials experts. During this meeting, each weapon system and its draft report are reviewed separately. The sessions are led by the cognizant system managers from Sandia and either Livermore or Los Alamos. The managers respond first to submitted questions and concerns and then ask for additional questions from attendees. "It's not a meeting to force consensus but rather an opportunity to air issues and hear other viewpoints," comments Tyler.

Drafts Receive DoD Review

By late April, the California and New Mexico teams complete amended drafts of the laboratories' Annual Assessment Reports. These drafts, which incorporate comments from the New Mexico meeting, are provided to the Project Officers Groups (POGs) as input for their own Annual Certification Assessment Reports. "A POG is a group of NNSA and DoD personnel who

A test launch of the Peacekeeper ICBM, which is equipped to carry the W87 warhead.

Lawrence Livermore–Designed Warheads in the U.S. Stockpile

Warhead/ Bomb Mark	Description	Carrier	Primary Use	Military Service
W62	ICBM (intercontinental ballistic missile) warhead	Minuteman III ICBM	Surface to surface	Air Force
B83-0/1	Strategic bomb	B-52, B-2 bombers	Air to surface	Air Force
W87	ICBM warhead	Peacekeeper ICBM	Surface to surface	Air Force
W84 (inactive)	Cruise missile warhead	None at present (formerly Ground Launched Cruise Missile)	None at present	Air Force

Annual Certification Based on Stockpile Stewardship

In 1995, President Clinton announced that the nation would begin a program called Stockpile Stewardship. This program would use science-based methods to assess the safety and reliability of the nation's nuclear stockpile in the absence of nuclear testing. The president also called for a new Annual Certification procedure as a formal way to periodically assess and report the status of the stockpile under the new program.

"I am today directing the establishment of a new annual reporting and certification requirement that will ensure that our nuclear weapons remain safe and reliable under a comprehensive test ban," President Clinton declared. Under this arrangement, the secretaries of Defense and Energy receive annual formal assessments from directors of the three weapons laboratories—Livermore, Los Alamos, and Sandia—the commander-in-chief of the U.S. Strategic Command, and the Nuclear Weapons Council.

Some experts have compared the challenges of stockpile stewardship to the World War II Manhattan Project to develop the atomic bomb or the Apollo program to safely land a man on the moon. The reason, in part, is that nuclear weapons are extremely complex devices. Many factors greatly influence the performance of thousands of components in ways that are not fully understood.

Livermore's stockpile stewardship work involves researchers from the Defense and Nuclear Technologies, Engineering, National Ignition Facility Programs, Chemistry and Materials Science, Computation, and Physics and Advanced Technologies directorates. These researchers rely on data from past nuclear tests, past and presesnt nonnuclear tests, fundamental science and component-level experiments, surveillance of actual weapons withdrawn from the stockpile, and advanced simulations. This approach has enabled them to successfully address stockpile issues.

Weapons of Good Pedigree

The weapons intended for the enduring stockpile all have good pedigrees—they went into the stockpile with blue-chip credentials. However, regular inspections of aging components have led to modifications of some weapons in the stockpile.

As with all nuclear weapons, those designed at Livermore use a wide range of materials. Changes related to aging and to interactions among materials have been observed in a number of systems and in unexpected ways, especially as systems age beyond their design lifetimes. For example, organic materials such as plastics decompose, metal joinings corrode, and many materials change properties unpredictably in response to radioactive environments.

When modifications are deemed necessary, scientists and engineers assess options for refurbishing or replacing specific components, including new production and fabrication processes and materials. Modification actions must then be formally validated. At Livermore, scientists and engineers also have broader responsibilities to develop assessment capabilities, technologies, and processes that contribute to maintaining the safety and reliability of all stockpiled weapons.

Livermore scientists use a unique collection of tools to examine and test the many materials that make up a weapon. Many of these tools were developed or modified at Livermore. For example, one tool samples gases inside a weapon's interior environment to identify potential material interactions, monitor aging indicators, and screen for defects such as incompletely cured adhesive.

Process Requires Special Studies

One special effort for stockpile surveillance is monitoring the chemical high explosives that are detonated to implode a plutonium pit. Livermore scientists are studying the long-term stability of the complex organic molecules making up high explosives. They examine samples from the stockpile for changes in appearance and texture; measure their physical, chemical, and mechanical properties; and conduct performance tests on them.

Likewise, a focused effort is under way to better understand the aging mechanisms of plutonium pits because this understanding is crucial to predicting weapon performance. (See "It's the Pits in the Weapons Stockpile," pp. 18–20.) In the same vein, data from underground subcritical experiments at the Nevada Test Site contribute information on the fundamental nature of plutonium and the effects of aged plutonium.

The knowledge gained from examining nuclear weapon components and materials and their aging mechanisms is used to increase the fidelity of computer codes. Realistic computer simulations then can predict the mechanisms of material failure and reveal the likely effects of substituting different materials. NNSA's Accelerated Strategic Computing Initiative is rapidly pushing computational power far beyond present capabilities so scientists can better simulate the aging of nuclear weapons and predict their performance.

NNSA is also investing in advanced experimental facilities such as the National Ignition Facility, under construction at Livermore, and the Dual-Axis Radiographic Hydrodynamic Test Facility, under construction at Los Alamos. The new capabilities will be needed to address the most challenging stockpile performance issues that can be expected to arise as weapons systems continue to age.

manage a particular nuclear warhead or bomb," says Tyler.

POG meetings, held at various locations in early May, include a review of the DoD aspects of each weapon system, for example, how a DoD reentry vehicle integrates with the NNSA warhead components it contains. In that respect, POG meetings review weapon systems in a broader context than earlier meetings attended by just DOE, NNSA, and laboratory staff. Livermore representatives return from the POG meetings with new comments for inclusion in the laboratories' final Annual Assessment Reports.

During May, Livermore senior managers also review the status of the four Livermore stockpile systems. The weapon system managers and technical staff give extensive briefings on these systems to the associate director for Defense and Nuclear Technologies, covering all the technical details that could have bearing on the current or future health of the system.

In June, Livermore managers coordinate their Annual Certification results to NNSA. Following this briefing, Laboratory scientists make a formal presentation to the Stockpile Assessment Team of the U.S. Strategic Command (STRATCOM), the DoD unified command agency for the nation's nuclear forces. This forum provides an opportunity for the entire national security community to review the information together. The Stockpile Assessment Team is STRATCOM's advisory panel for stockpile status and issues. The June meeting supports STRATCOM's Annual Certification Report and the letter to the Secretary of Defense signed by the commander-in-chief, U.S. Strategic Command (CINCSTRAT). The meeting is also attended by representatives from NNSA and DoD agencies and by the Panel to Assess the Reliability, Safety and Security of the United States Nuclear Stockpile. This panel, established by law, is headed by former Livermore director John S. Foster. The meeting gives valuable feedback to Livermore managers about their stockpile stewardship roles, says Tyler.

Briefings for the Director

During the summer, the director receives extensive briefings on the status of the Livermore-designed stockpile systems in preparation for his letter to the secretaries of Energy and Defense. The briefings, presented by weapon system managers and attended by other senior Livermore weapons scientists and managers, reflect comments and issues raised during the previous meetings. This year, for the first time, members of the University of California's National Security Panel will also attend.

After the director's review, the final versions of the four Lawrence Livermore/Sandia Annual Assessment Reports are issued late in July. For each report, a transmittal letter is signed by the associate director for Defense and Nuclear Technologies and by the cognizant Sandia vice president. These final reports are sent to other laboratories and to NNSA, which forwards them to the POGs, appropriate DoD agencies, and the White House.

The directors' letters to the secretaries of Energy and Defense are issued in the fall. In his letter, the Livermore director states whether he believes a resumption of nuclear testing is warranted for Livermore-designed systems.

The CINCSTRAT letter to the Secretary of Defense is also transmitted in the fall. The Nuclear Weapons Council, established by law to coordinate all nuclear weapons activities for the nation, now enters the picture. The council, composed of senior officials from the NNSA and DoD, issues its report on the stockpile in November or December. It does so after receiving input from its Nuclear Weapons Council Standing and Safety Committee, which reviews and considers the reports, briefings, and letters from the laboratories, POGs, and STRATCOM.

The Annual Certification Memorandum from the secretaries of Energy and Defense to the president is issued after their staffs have analyzed the material submitted by the laboratories and other agencies. Beginning in 2000, this memorandum is classified to help ensure that accurate technical assessments can always be included. (See box with the 1999 memorandum on p. 10.)

Annual Certification is based on ongoing stockpile stewardship work. The work consists of surveillance, assessment, response, and baselining. Baselining, in turn, consists of day-to day activities such as computer simulations, subcritical experiments of plutonium at the Nevada Test Site, and nonnuclear tests at Livermore's remote Site 300.

Central Role

Five cycles of the Annual Certification have now been completed, and this yearly review has assumed a central role in stockpile stewardship. On many levels, the Annual Certification uniquely benefits the nation's security and offers advantages to Livermore stockpile stewards, says Tyler. First, the Laboratory's stockpile stewardship activities receive "a good scrubbing" from its own people, other NNSA laboratory experts, and knowledgeable people from DoD agencies and outside panels. The process generates valuable feedback and "sharpens our stockpile stewardship activities," Tyler says. By the same token, NNSA and DoD agencies learn firsthand from the laboratories about current stockpile status. The interactions help ensure that the nation's nuclear security community has a common understanding of the status of the nuclear stockpile.

—Arnie Heller

Key Words: Annual Certification, National Nuclear Security Administration (NNSA), Nuclear Weapons Council, Project Officers Groups (POGs), stockpile stewardship, subcritical experiments, U.S. Strategic Command.

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Annual Certification Memorandum for 1999

MEMORANDUM FOR THE PRESIDENT

SUBJECT: Nuclear Stockpile Certification

In response to your direction to conduct an annual certification of the nuclear weapons stockpile, we have thoroughly reviewed the safety and reliability of the stockpile. The nuclear stockpile has no safety or reliability concerns that require underground nuclear testing at this time. Problems that have arisen in the stockpile are being addressed and resolved without underground nuclear testing to ensure the stockpile remains safe and reliable. In reaching this conclusion, we have obtained the advice of the Directors of the National Weapons Laboratories, the Commander in Chief, United States Strategic Command, and the Nuclear Weapons Council. We will continue to inform you annually on the safety and reliability of the nuclear weapons stockpile in the absence of underground nuclear testing, and in the context of the DOE's Stockpile Stewardship Plan.

Bill Richardson
Secretary of Energy

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William S. Cohen
Secretary of Defense

Executed: April 5, 2000

About the Scientist

JAMES TYLER received a B.A. in physics from Vanderbilt University in 1966 and a Ph.D. in nuclear physics from the University of Wisconsin at Madison in 1973. He joined the Laboratory in August 1973. At Livermore, he has designed nuclear explosives, managed two warhead development projects, managed studies of possible future warheads, and been on staff supporting the Military Applications Office and the Defense and Nuclear Technologies (DNT) Directorate. At present, Tyler is the program manager for Stockpile Support in DNT. As such, he is involved in extensive interface activities between the Livermore nuclear weapons program and corresponding organizations in the National Nuclear Security Administration, the Department of Defense, and the Los Alamos and Sandia national laboratories. A major part of this work is the management of Livermore's yearly efforts supporting the process for Annual Certification of the nation's nuclear stockpile. Tyler is also the program manager for the Evaluation and Planning Program, which comprises systems analysis and weapons effects studies.